Small-Scale Natural Gas to Liquid Fuels Conversion Using Internal Combustion Engines

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A significant quantity of natural gas in the world is flared due to prohibitive transportation and processing costs that make it uneconomical in a gaseous state. This gas ('stranded gas') typically exists as associated gas at oil wells, where transportation of liquid petroleum to market is economical, though that of gas is not. As a result, it is flared and therefore wasted. One way to eliminate this waste is to perform gas to liquid (GTL) conversion at the source. Since the natural gas source is relatively small, the conversion requires compact GTL plants. A system techno-economic and market analysis of small-scale methanol production using syngas that is produced in an internal combustion engine ('engine reformer'), using methane from a stranded gas source has been performed and shows that methanol produced in this way can be competitive with conventional methanol production. Other liquid products may also be considered.

This work includes a new GTL technology that promises significantly more favourable cost-scaling. In particular, focus is on an experimental apparatus to characterize a new reformer technology based on internal combustion engines.

Reforming natural gas in an internal combustion has been suggested in the past for some applications, but the present application of compact, integrated fuel production is novel. The system developed investigates partial oxidation of rich methane mixtures.

A diesel engine is selected for its robust construction and tolerance of high peak cylinder pressure and pressure rise rates. The engine is adapted for spark-ignition operation and thoroughly instrumented.

Experimental results show that combustion of rich methane-air mixtures are limited by the flame propagation limit. However, the rich fuel equivalence ratio limit has been extended with intake mixture preheating and oxygen and hydrogen enrichment of the intake air stream. Both measures advance heat release phasing and lead to higher peak heat release rates.